A Framework for Integrated Analysis of Distributed Energy Resources: Guide for States

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1 Electric vehicle section

August 17, 2018

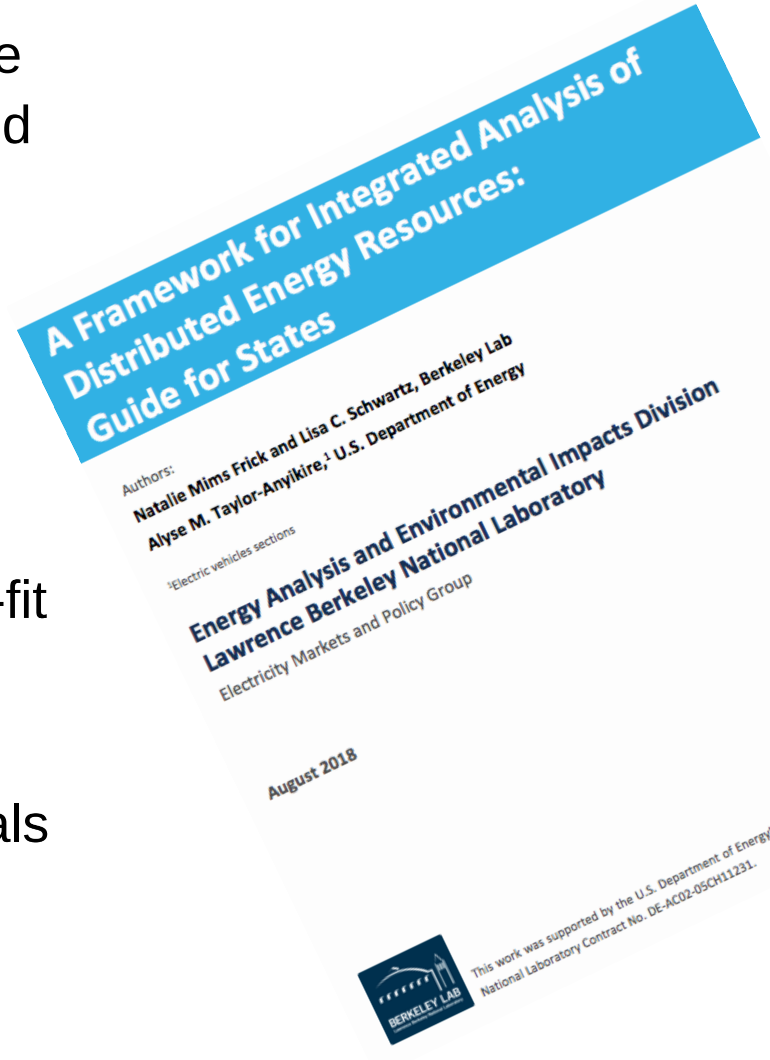
This work was supported by the U.S. Department of Energy's Office of Energy Policy and Systems Analysis under Lawrence Berkeley National Laboratory Contract No. DE-AC02-05CH11231

Context

- Electric utilities have been planning for and investing in energy efficiency and demand response for more than three decades.
- However, the scope of distributed energy resources (DERs) that are economic has grown and utility planning and investment in these resources now includes distributed photovoltaics, storage and electric vehicles.
- Electric utility planning around DERs has struggled to keep up with changes in DER costs and functionality.
- Few planning efforts have accounted for how multiple types of DERs interact with one another to affect savings or generation estimates, or forecasts of electricity system impacts and benefits.
- New, more integrated approaches to considering DER options are emerging and have the potential to identify a lower cost resource mix, improve reliability, and reduce air pollution emissions.

Audience and Uses for Guide

- The target audiences for the guide are state policymakers, public utility commissions and state energy offices. Other stakeholders include utilities, consumer representatives, consultants, and DER product and service providers.
- Uses for the guide:
  - Advance identification of least-cost, best-fit resource plans and strategies
  - Inform grid modernization efforts
  - Support achievement of state energy goals
  - Serve as practical guidance at the state level or for utility service areas within a state


A Framework for Integrated Analysis of Distributed Energy Resources: Guide for States

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August 2018

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Approach

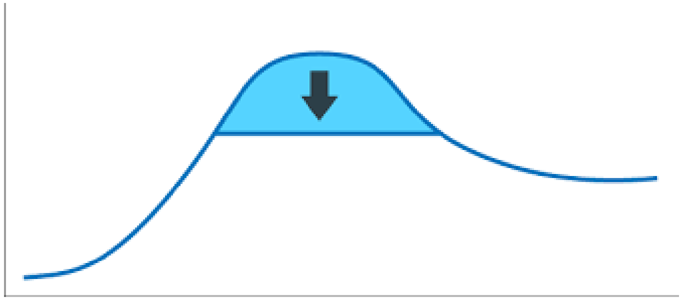
- Literature review of existing research on DERs and electric utility planning efforts that consider multiple DERs
  - Over 100 reports and utility filings were reviewed.
  - Many utilities and states have included individual DERs in electric utility planning, few have undertaken *integrated* analysis of DERs.
- Interviews with state public utility commissions, electric utilities, independent system operators, regional planning organizations, and DER consultants.
  - Integrated DER analysis would be useful to inform policies, regulations, and programs.
  - Very limited information available about the critical assumptions that must be made, or the order in which the assumptions should be made, to integrate individual DERs into a cumulative impact
  - Very little information on the additional cost of considering resources in an integrated way

Scope: DERs Considered in the Guide

Energy Efficiency

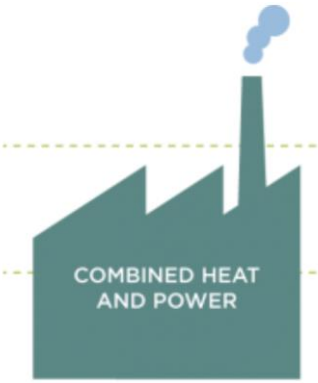
Electric Vehicles

Demand Response



Solar

Combined Heat and Power



Storage

Scope: Utility Planning Processes in the Guide

Demand-Side Management Planning

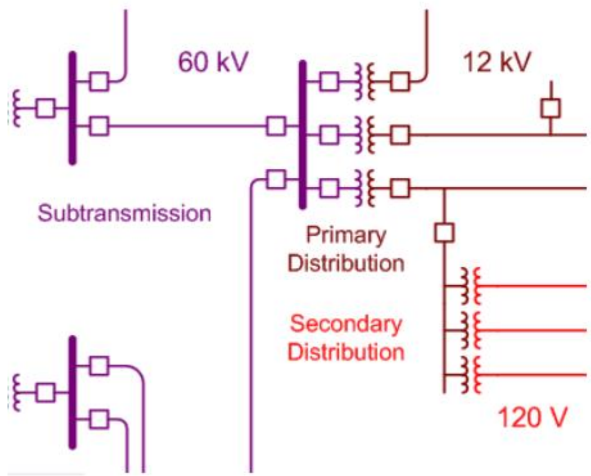
Energy Efficiency Potential and Goals Study for 2018 and Beyond

Final Public Report

Prepared for:

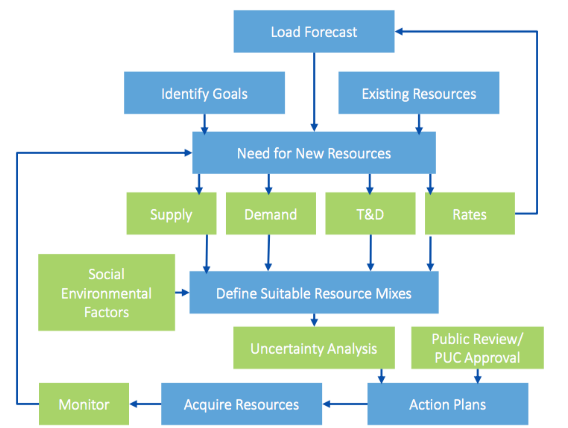
California Public Utilities Commission

Distribution Planning



Resource Planning

Flow Chart for Integrated Resource Planning

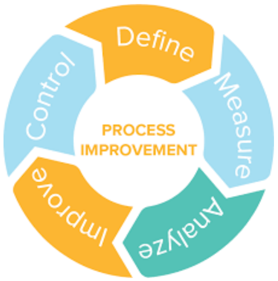


Source: Integrated Resource Planning for State Utility Regulators. Available at: http://www.raponline.org/document/download/id/817

Scope: What is NOT in the Guide

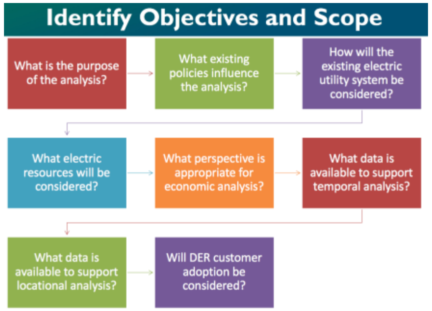
- The guide seeks to provide states — with diverse starting points — a path forward to analyze DERs in an integrated way.
- The guide is NOT a:
  - Detailed explanation or comprehensive overview of DER potential studies, DSM plans, IRPs or distribution system planning
  - Comprehensive documentation of all DER-related literature
  - Review of models that are available to conduct integrated DER analysis

Framework Approach

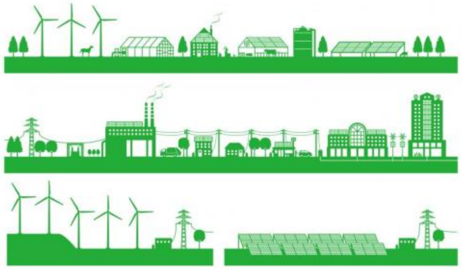


Assess results for errors and insights to continually improve analyses over time

Identify objectives and scope

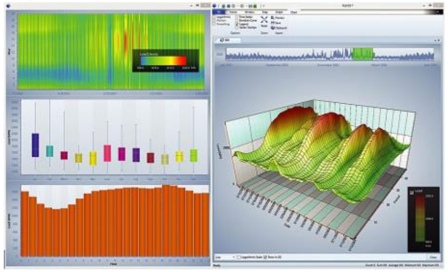


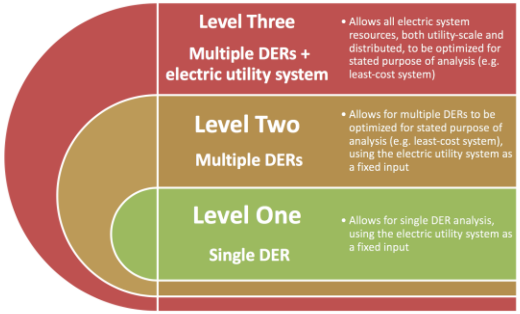
Define electric resources



Define analysis approach

Conduct analysis





All levels incorporate temporal analysis and can incorporate locational values.

Framework for Integrated Analysis of DERs

Level Three

Multiple DERs + electric utility system

- Allows all electric system resources, both utility-scale and distributed, to be optimized for stated purpose of analysis (e.g., least-cost system)

Level Two

Multiple DERs

- Allows for multiple DERs to be optimized for stated purpose of analysis (e.g., least-cost system), using the electric utility system as a fixed input

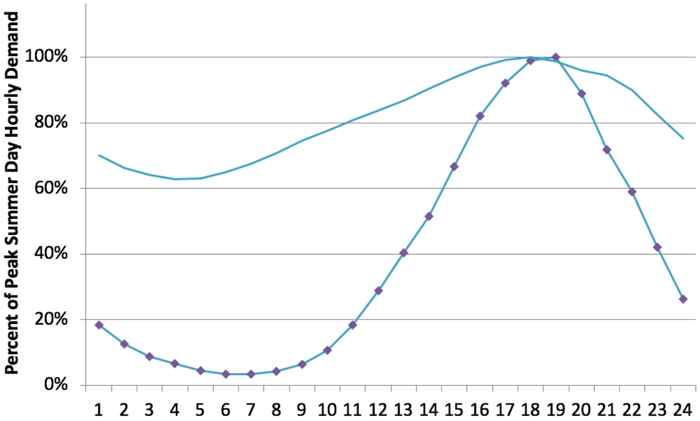
Level One

Single DER

- Allows for single DER analysis, using the electric utility system as a fixed input

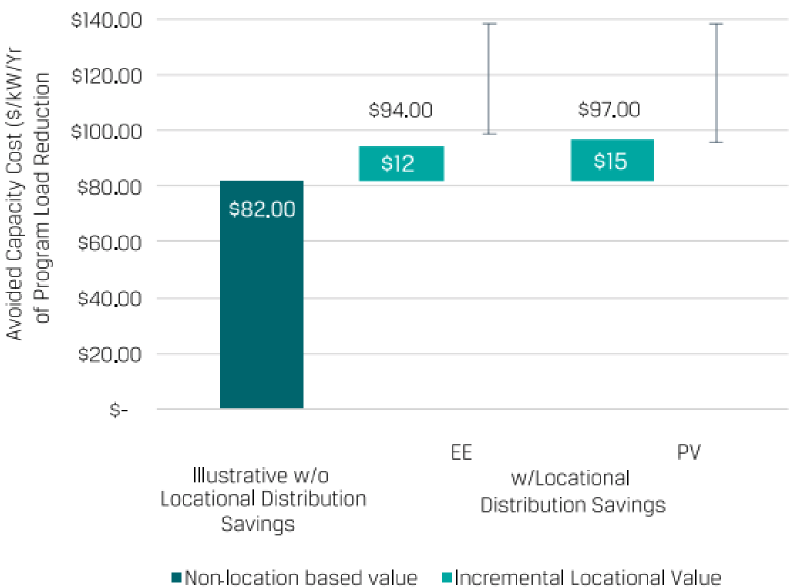
All levels incorporate temporal analysis and can incorporate locational values.

Temporal Analysis



Energy savings or generation output from DERs occur at different times depending on DER type — and, in the case of efficiency, demand response and storage, building type (e.g., a school versus a factory). The value of DERs from one time period to another varies based on factors such as generation mix and demand. As used in the guide, temporal analysis applies the estimated cost and value of DERs on a granular time basis within each year, such as by hour, day, month, or season.

Locational Analysis



Source: ICF

The value of DERs is heavily dependent on their location, based on factors such as generation mix and demand. As used in the guide, locational analysis applies the estimated cost and value of DERs on a circuit or substation level.

Level One: Single DER

- Analysis outcome:
  - Quantification of available savings or generation — energy (kWh) and/or demand (kW), depending on the DER type
  - Quantification of kWh or kW savings or generation that is economic
- Electric utility system avoided cost is a fixed value in analysis.
- Temporal analysis: Hourly, daily, monthly or seasonal kWh or kW savings or generation may be used in the analysis. Hourly, daily, monthly or seasonal avoided costs may be used in the analysis.
- Locational analysis: kWh and kW savings or generation may be identified at a specific circuit or substation. A variety of locational values may be incorporated in analysis (e.g., avoided costs including: distribution capacity, transmission capacity, generation capacity, energy).
- Benefits: Level One analysis allows for a simplified DER analysis.
- Challenges: Exclusion of the ability of DERs to change the optimal portfolio produces results that can over-or underestimate the amount of DERs that are optimal on the system.

Level Two: Multiple DERs

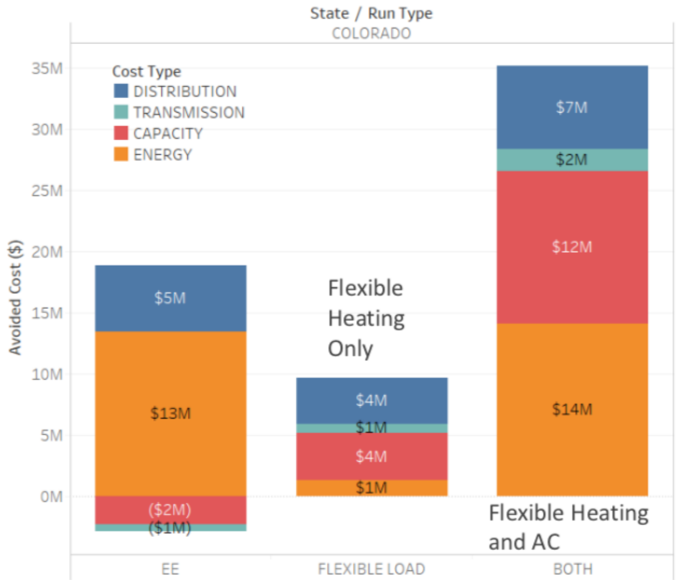
- Analysis outcome:
  - Quantification of available savings or generation — energy (kWh) and/or demand (kW) — for multiple DERs, considering their interactions
  - Quantification of kWh or kW savings or generation of multiple DERs, considering their interactions, that is economic
- Electric utility system avoided cost is a fixed value in analysis.
- Temporal analysis: Hourly, daily, monthly or seasonal kWh or kW savings or generation may be used in the analysis. Hourly, daily, monthly or seasonal avoided costs may be used in the analysis.
- Locational analysis: kWh and kW savings or generation may be identified at a specific circuit or substation. A variety of locational values may be incorporated in analysis (e.g., avoided costs including: distribution capacity, transmission capacity, generation capacity, energy).
- Benefits: Level Two allows for a simplified integrated DER analysis that considers the interactive effects of two or more DERs.
- Challenges: Exclusion of the ability of DERs to change the optimal portfolio produces results that can over-or underestimate the amount of DERs that are optimal on the system.

Level Three: Multiple DERs + Electric Utility System

- Analysis outcome: Identification of the optimal mix of resources, and cost of that resource mix, that meets the stated purpose of the analysis (e.g., lowest cost, most reliable electric utility system).
- Electric utility system avoided costs are dynamically determined through an optimization model.
- Temporal analysis: Hourly kWh and kW savings or generation and hourly avoided costs are used in the analysis.
- Locational analysis: kWh and kW savings or generation may be identified at a specific circuit or substation. A variety of locational values may be incorporated in analysis (e.g., avoided costs including: distribution capacity, transmission capacity, generation capacity, energy).
- Benefits: Level Three analysis comprehensively solves for the stated purpose of the analysis from an electric system-wide perspective. Interactive effects, both between DERs and DERs and the electric utility system are considered.
- Challenges: There are increased cost and data requirements to create robust results and resources.

Use Cases: Demand-Side Management Planning

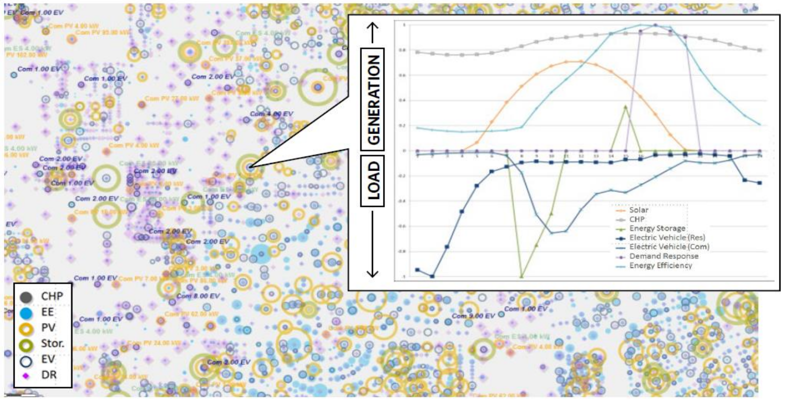
- Evolved Energy and the U.S. Department of Energy
  - Assessed combined impacts of efficiency and demand response
  - Combining efficiency with flexible load can increase the number of cost-effective efficiency measures

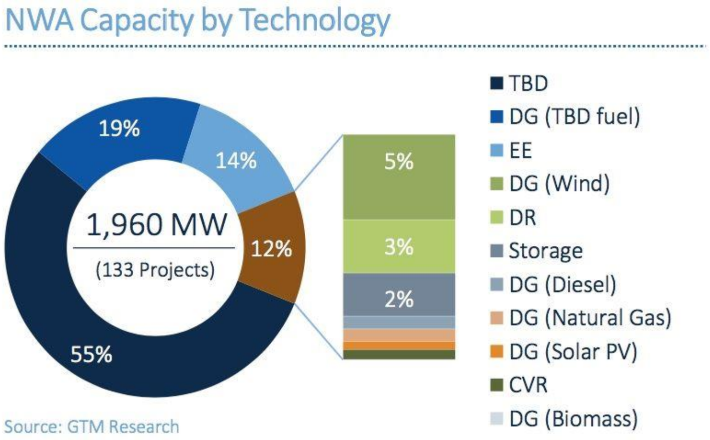


- Berkeley Lab and the California Public Utilities Commission's Demand Response Potential Study
  - Efficiency combined with demand response could increase overall demand reductions
- Berkeley Lab's integrated demand-side management study
  - Opportunities to integrate implementation features of efficiency and demand response to reduce cost and increase participation

Use Cases: Distribution Planning

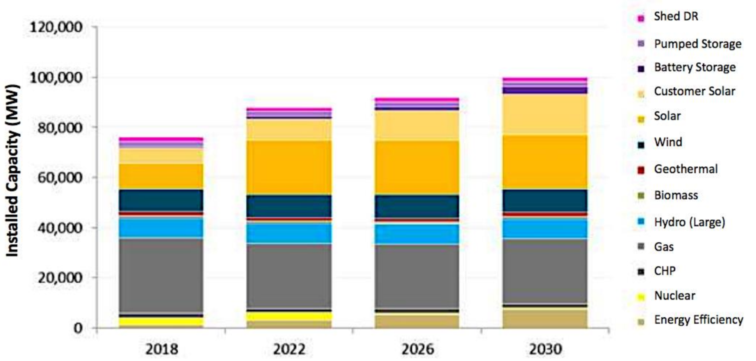
- Berkeley Lab's recent reports on distribution planning by state and distribution planning by topic and distribution system trainings provide examples where multiple DERs are used in:
  - DER resource plans
  - Hosting capacity analysis
  - Locational net benefits
  - Non-wires alternatives

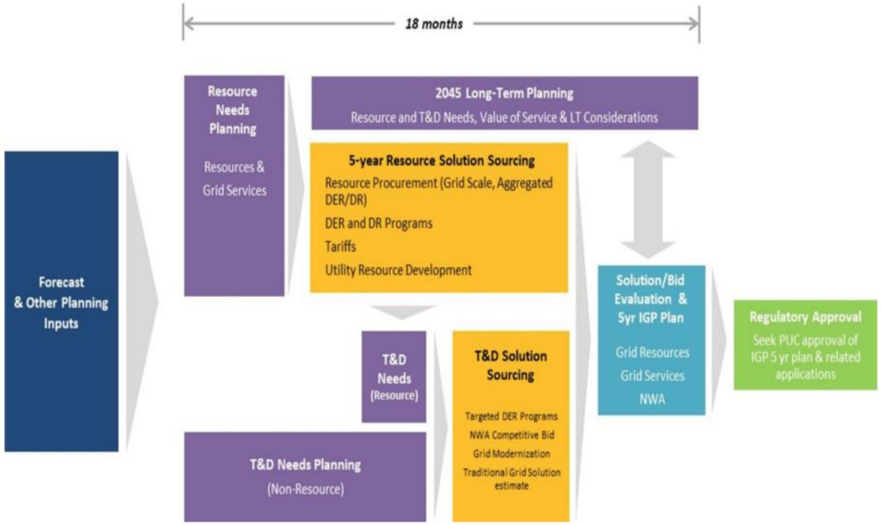




Use Cases: Resource Planning

- California Public Utilities Commission integrated resource planning reference case includes many DERs (efficiency, battery, distributed solar, demand response) in combination with supply side resources
- Pacific Northwest Power & Conservation Council's Seventh Plan considered efficiency, demand response and distributed solar in combination with supply side resources
- Hawaiian Electric proposed to include grid-scale resources, aggregated DER and DR* in its Integrated Grid Planning process





*Hawaiian Electric does not define DERs in their integrated grid plan. They list DER and DR separately as resources.

Observations and Next Steps

- Integrated analysis of DERs in electric utility planning may identify a least-cost resource mix and DER opportunities that would otherwise be missed when planning these resources in isolation. However, the high fidelity of requisite data, which may include temporal and locational value, and complex modeling required to integrate multiple DERs into electric utility system planning may be challenging and time consuming. Examples of integrated analysis of DERs provide limited guidance.

- Potential opportunities for publicly available research include:
  - Guidelines for DER benefit-cost analysis
  - Interactive effects of combinations of DERs for demand-side management planning, distribution system planning and resource planning
  - Necessary key assumptions for creation of combinations of DERs for Level Two (analysis of two or more DERs with a fixed electric utility system) and Level Three (analysis of two or more DERs with a dynamic electric utility system) analyses
  - A clearinghouse of case studies, as examples of integrated DER analysis grow, that makes the information more readily available to states, utilities and stakeholders
  - Identifying and categorizing key policy drivers to promote integrated DER analysis in electric utility system planning

Questions?

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Additional Slides

Overview of Framework

	Level 1	Level 2	Level 3
No. of DERs	One DER	Two or more DERs	
Level of DER Integration	Limited, if any	Integrated analysis considering multiple DERs impact on each other	Integrated analysis considering multiple DERs impact on all electric utility system resources
Electric utility system interaction	Avoided costs are assumed to be a fixed value	Avoided costs are assumed to be a fixed value, and must be on same time scale as combinations of DERs being considered	Avoided costs are dynamically determined
Analysis outcome*	• Quantification of available savings or generation— energy (kWh) and /or demand (kW) (depending on the DER type) • Quantification of kWh or kW savings or generation that is economic		Identification of the optimal mix of resources, and cost of that resource mix, that meets the stated purpose of the analysis
Temporal analysis	• Hourly, daily, monthly or seasonal kWh or kW savings or generation may be used in the analysis • Hourly, daily, monthly or seasonal avoided costs may be used in the analysis		• Hourly kWh and kW savings or generation • Hourly avoided costs
Locational analysis	• kWh and kW savings or generation may be identified at a specific circuit or substation • Variety of locational values may be incorporated in analysis (e.g., avoided costs including: distribution capacity, transmission capacity, generation capacity, energy)		
Benefit	Level One analysis allows for a simplified DER analysis.	Level Two allows for a simplified integrated DER analysis that considers the interactive effects of two or more DERs.	Level Three analysis comprehensively solves for the stated purpose of the analysis from an electric system-wide perspective. Interactive effects, both between DERs and DERs and the electric utility system are considered.
Challenges	Exclusion of the ability of DERs to change the optimal portfolio produces results that can over-or underestimate the amount of DERs that are optimal on the system.	Exclusion of the ability of DERs to change the optimal portfolio produces results that can over-or underestimate the amount of DERs that are optimal on the system.	There are increased cost and data requirements to create robust results and resources.

Identify Objectives and Scope

What is the purpose of the analysis? → What existing policies influence the analysis? → How will the existing electric utility system be considered?

→ What electric resources will be considered? → What perspective is appropriate for economic analysis? → What data is available to support temporal analysis?

→ What data is available to support locational analysis? → Will DER customer adoption be considered?

Range of Temporal Data for Efficiency

High Resolution

Sub-hourly (e.g., 15-minute interval data)
Hourly annual (8,760) data
Peak day/off-peak day
Monthly data with weekday vs. weekend/holiday
Seasonal data with weekday vs. weekend/holiday
Monthly data
Seasonal (e.g., quarterly) data
Annual energy savings by measure, program or portfolio

Low Resolution